

Tomer Fishman, PhD
Curriculum Vitae • November 2022

Institute of Environmental Sciences (CML), Faculty of Science,
Leiden University, The Netherlands
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Research interests

- Material stock & flow accounting and analysis
- Socio-economic metabolism
- The circular economy
- Drivers of material consumption
- Resource management
- Statistical, econometric, and stochastic analysis and forecasting of material use
- Geospatial (GIS) analysis of material stocks

Current projects

- Remote sensing of urban material stock accumulation typologies. Mapping and analysis of the global materials stocked in buildings & infrastructure using machine learning & satellite imagery.
- Country- and global-scale drivers, trends, and forecasts of material stock & flow processes.
- Resource efficiency scenarios and priorities for countries and the planet.
- Scenarios of demand and supply of critical materials in emerging green technologies.

Academic Employment

- 2021-Present Assistant Professor
Institute of Environmental Sciences (CML), Faculty of Science, Leiden University, The Netherlands
- 2017-Present Adjunct Assistant Professor
School of Environment, Enterprise and Development, Waterloo University, Canada
- 2020-Present IIASA-Israel Program Visiting Associate Professor Fellow, International Institute for Applied Systems Analysis (IIASA), Austria.
- 2018-2021 Lecturer
School of Sustainability, Reichman University – Interdisciplinary Center (IDC) Herzliya, Israel
- 2016-2018 Postdoctoral associate
Center for Industrial Ecology, School of Forestry & Environmental Studies, Yale University, USA
- 2016 Special appointment lecturer
Graduate School of Environmental Studies, Nagoya University, Japan

2013, 2014 Visiting researcher
Ecosystems Sciences, Commonwealth Scientific and Industrial Research
Organisation (CSIRO), Australia

Education

- 2016 PhD, Environmental Studies
Graduate School of Environmental Studies
Nagoya University, Nagoya, Japan
Supervisors: Prof. Hiroki Tanikawa and Prof. Heinz Schandl
Thesis title: *Material stock accumulation in society: modeling, forecasts, and socio-economic drivers*
- 2013 Master of Engineering
Graduate School of Environmental Studies
Nagoya University, Nagoya, Japan
Thesis title: *A model of material saturation using long-term stocks and flows in Japan and the United States*
- 2009 Bachelor of Arts, Economics and East Asian Studies
Faculty of Social Sciences
The Hebrew University of Jerusalem, Israel

Teaching

- 2021-2022 Leiden University
Material Flow Analysis I
Material Flow Analysis II
Spatial Analysis in Urban Regions
Big Issues New Answers: Economy & Technology module
- 2018-2021 Reichman University:
Sustainable Production and Consumption
Introduction to Geographic Information Systems
Introduction to Ecology
Sustainable Development
Sustainability & Mobility
- 2017-2018 Yale School of Forestry & Environmental Studies:
Material Flow Analysis and Socioeconomic Metabolism
- 2015-2016 Nagoya University Environmental System Analysis and Planning Lab:
Introduction to Industrial Ecology
Practice in Environmental Systems Analysis and Planning

Appointments

- 2019-Present Co-chair of the conference committee, International Society of Industrial Ecology
- 2019-Present Board member, Socio-economic Metabolism Section, International Society of Industrial Ecology
- 2015 - 2016 Organizing committee, Joint 12th ISIE Socio-Economic Metabolism Section Conference and the 5th ISIE Asia-Pacific Conference, 28-30 September 2016, Nagoya, Japan.

- 2015 Chair of the Fourth Symposium on Industrial Ecology for Young Professionals, 11 July 2015, University of Surrey, Guildford, UK.
- 2014 - 2015 President of the student chapter of the International Society for Industrial Ecology.
- Reviewer for *Nature Communications; Proceedings of the National Academy of Science; Environmental Science & Technology; Ecological Economics; Journal of Cleaner Production; Journal of Environmental Planning and Management; Journal of Industrial Ecology; Resources, Conservation & Recycling; Science of the Total Environment; Sustainable Chemistry & Engineering; Waste Management.*

Awards and scholarships

- 2020 Resources Best Paper Award for *Fishman et al. 2018 Implications of Emerging Vehicle Technologies on Rare Earth Supply and Demand in the United States.*
- 2019 Interdisciplinary Center Herzliya, Excellence in Teaching 2019 award.
- 2018 Winner of the 2018 Critical Materials Institute Winter Meeting poster competition.
- 2017 Excellence in Review Award 2016, The Journal of Resources, Conservation & Recycling (Elsevier).
- 2010 - 2016 Japanese Government MEXT (Monbukagakusho-文部科学省) full scholarship.
- 2014 Winner of the 2014 Industrial Ecology Gordon Research Conference poster competition.
- 2008 Honors Student, Department of East Asian Studies, The Hebrew University of Jerusalem.

Research Grants

- 2022 Horizon Europe *CircoMod*, HORIZON-CL5-2021-D1-01-02 project 101056868. Consortium partner, €5,000,000.
- 2020 The Ministry of Energy of Israel (Israel-EU JRC collaboration) *Mapping and modeling Israel's Water-Energy-Food-Ecosystem nexus*. With Kan I. from the Hebrew University and Parag, Y., Zemah Shamir S., & Yair, Y. from the IDC Herzliya, NIS 750,000 (ca. \$225,000).
- 2020 National Building Research Institute of Israel *BIM-LCA Process Design for Low-Carbon Building Material Passports* With Spatari, S. from the Technion Israel Institute of Technology, NIS 230,000 (ca. \$70,000).
- 2019 Israel Science Foundation (ISF) *RUSTY: Remote sensing of Urban material Stock accumulation Typologies*, personal grant No. 2706/19, NIS 563,000 (ca. \$170,000).
- 2015 The National Science Foundation, Grant no. 1523263 *The fourth Symposium on Industrial Ecology for Young Professionals*, \$49,775.

Other Professional Experience

- 2007 - 2010 Movie production and IT/website manager
The Hebrew University of Jerusalem, Israel
- 2005 - 2006 Cellular data support specialist and instructor
Partner Communications Ltd., Israel

2001 - 2004 Commanding officer of battlefield medicine training program
Israel Defense Forces

Publications

Peer-reviewed journal articles

1. Ma, F.; Wang, H.; Schandl, H.; Fishman, T.; Tan, X.; Li, Y.; Shi, L.; Wang, P.; Chen, W.-Q. Exploring the Relationship between Economic Complexity and Resource Efficiency. *Resources, Conservation and Recycling* **2022**, *186*, 106530.
2. Sims, Z. C.; Kesler, M. S.; Henderson, H. B.; Castillo, E.; Fishman, T.; Weiss, D.; Singleton, P.; Eggert, R.; McCall, S. K.; Rios, O. How Cerium and Lanthanum as Coproducts Promote Stable Rare Earth Production and New Alloys. *Journal of Sustainable Metallurgy* **2022**.
3. Pauliuk, S.; Heeren, N.; Berrill, P.; Fishman, T.; Nistad, A.; Tu, Q.; Wolfram, P.; Hertwich, E. G. Global Scenarios of Resource and Emission Savings from Material Efficiency in Residential Buildings and Cars. *Nature Communications* **2021**, *12* (1), 5097.
4. Fishman, T.; Heeren, N.; Pauliuk, S.; Berrill, P.; Tu, Q.; Wolfram, P.; Hertwich, E. G. A Comprehensive Set of Global Scenarios of Housing, Mobility, and Material Efficiency for Material Cycles and Energy Systems Modeling. *Journal of Industrial Ecology* **2021**.
5. Wiedenhofer, D.; Fishman, T.; Plank, B.; Miatto, A.; Lauk, C.; Haas, W.; Haberl, H.; Krausmann, F. Prospects for a Saturation of Humanity's Resource Use? An Analysis of Material Stocks and Flows in Nine World Regions from 1900 to 2035. *Global Environmental Change* **2021**, *71*, 102410.
6. Peled, Y.; Fishman, T. Estimation and Mapping of the Material Stocks of Buildings of Europe: A Novel Nighttime Lights-Based Approach. *Resources, Conservation and Recycling* **2021**, *169*, 105509.
7. Tanikawa, H.; Fishman, T.; Hashimoto, S.; Daigo, I.; Oguchi, M.; Miatto, A.; Takagi, S.; Yamashita, N.; Schandl, H. A Framework of Indicators for Associating Material Stocks and Flows to Service Provisioning: Application for Japan 1990–2015. *Journal of Cleaner Production* **2021**, *285*, 125450.
8. Sprecher, B.; Verhagen, T. J.; Sauer, M. L.; Baars, M.; Heintz, J.; Fishman, T. Material Intensity Database for the Dutch Building Stock: Towards Big Data in Material Stock Analysis. *Journal of Industrial Ecology* **2021**.
9. Haberl, H.; Wiedenhofer, D.; Schug, F.; Frantz, D.; Virág, D.; Plutzer, C.; Gruhler, K.; Lederer, J.; Schiller, G.; Fishman, T.; Lanau, M.; Gattringer, A.; Kemper, T.; Liu, G.; Tanikawa, H.; van der Linden, S.; Hostert, P. High-Resolution Maps of Material Stocks in Buildings and Infrastructures in Austria and Germany. *Environmental Science & Technology* **2021**.
10. Ciacci, L.; Fishman, T.; Elshkaki, A.; Graedel, T. E.; Vassura, I.; Passarini, F. Exploring Future Copper Demand, Recycling and Associated Greenhouse Gas Emissions in the EU-28. *Global Environmental Change* **2020**.
11. Wiedenhofer, D.; Virág, D.; Kalt, G.; Plank, B.; Streeck, J.; Pichler, M.; Mayer, A.; Krausmann, F.; Brockway, P.; Schaffartzik, A.; Fishman, T., et al. A Systematic Review of the Evidence on Decoupling of GDP, Resource Use and GHG Emissions, Part I: Bibliometric and Conceptual Mapping. *Environmental Research Letters* **2020**.
12. Haberl, H.; Wiedenhofer, D.; Virág, D.; Kalt, G.; Plank, B.; Brockway, P.; Fishman, T.; Hausknost, D.; Krausmann, F.; Leon-Gruchalski, B.; et al. A Systematic Review of the

Evidence on Decoupling of GDP, Resource Use and GHG Emissions, Part II: Synthesizing the Insights. *Environmental Research Letters* **2020**.

13. Bradshaw, J.; Jit Singh, S.; Tan, S.-Y.; Fishman, T.; Pott, K. GIS-Based Material Stock Analysis (MSA) of Climate Vulnerabilities to the Tourism Industry in Antigua and Barbuda. *Sustainability* **2020**, *12* (19), 8090.
14. Pauliuk, S.; Fishman, T.; Heeren, N.; Berrill, P.; Tu, Q.; Wolfram, P.; Hertwich, E. G. Linking Service Provision to Material Cycles: A New Framework for Studying the Resource Efficiency-Climate Change (RECC) Nexus. *Journal of Industrial Ecology* **2020**.
15. Guo, J.; Fishman, T.; Wang, Y.; Miatto, A.; Wuyts, W.; Zheng, L.; Wang, H.; Tanikawa, H. Urban Development and Sustainability Challenges Chronicled by a Century of Construction Material Flows and Stocks in Tiexi, China. *Journal of Industrial Ecology* **2020**.
16. Huang, B.; Gao, X.; Xu, X.; Song, J.; Geng, Y.; Sarkis, J.; Fishman, T.; Kua, H.; Nakatani, J. A Life Cycle Thinking Framework to Mitigate the Environmental Impact of Building Materials. *One Earth* **2020**, *3* (5), 564–573.
17. Fishman, T.; Graedel, T. E. Impact of the Establishment of US Offshore Wind Power on Neodymium Flows. *Nature Sustainability* **2019**.
18. Hertwich, E. G.; Ali, S.; Ciacci, L.; Fishman, T.; Heeren, N.; Masanet, E.; Asghari, F. N.; Olivetti, E.; Pauliuk, S.; Tu, Q.; et al. Material Efficiency Strategies to Reducing Greenhouse Gas Emissions Associated with Buildings, Vehicles, and Electronics—a Review. *Environmental Research Letters* **2019**, *14* (4), 043004.
19. Heeren, N.; Fishman, T. A Database Seed for a Community-Driven Material Intensity Research Platform. *Scientific Data* **2019**, *6* (1), 23.
20. Symmes, R.; Fishman, T.; Telesford, J. N.; Singh, S. J.; Tan, S.; Kroon, K. The Weight of Islands: Leveraging Grenada’s Material Stocks to Adapt to Climate Change. *Journal of Industrial Ecology* **2019**.
21. Wiedenhofer, D.; Fishman, T.; Lauk, C.; Haas, W.; Krausmann, F. Integrating Material Stock Dynamics Into Economy-Wide Material Flow Accounting: Concepts, Modelling, and Global Application for 1900–2050. *Ecological Economics* **2019**, *156*, 121–133.
22. Fishman, T.; Myers, R. J.; Rios, O.; Graedel, T. E. Implications of Emerging Vehicle Technologies on Rare Earth Supply and Demand in the United States. *Resources* **2018**, *7* (1).
23. Makov, T.; Fishman, T.; Chertow, M.; Blass, V. What Affects the Second-Hand Value of Smartphones: Evidence from eBay. *Journal of Industrial Ecology* **2018**.
24. Myers, R. J.; Fishman, T.; Reck, B. K.; Graedel, T. E. Unified Materials Information System (UMIS): An Integrated Material Stocks and Flows Data Structure. *Journal of Industrial Ecology* **2018**.
25. Nguyen, R. T.; Fishman, T.; Zhao, F.; Imholte, D. D.; Graedel, T. E. Analyzing Critical Material Demand: A Revised Approach. *Science of The Total Environment* **2018**, *630*, 1143–1148.
26. Nguyen, T. C.; Fishman, T.; Miatto, A.; Tanikawa, H. Estimating the Material Stock of Roads: The Vietnamese Case Study. *Journal of Industrial Ecology* **2018**.
27. Martinico-Perez, M. F. G.; Schandl, H.; Fishman, T.; Tanikawa, H. The Socio-Economic Metabolism of an Emerging Economy: Monitoring Progress of Decoupling of Economic

Growth and Environmental Pressures in the Philippines. *Ecological Economics* **2018**, 147, 155–166.

28. Font Vivanco, D.; Hoekman, P.; Fishman, T.; Pauliuk, S.; Niccolson, S.; Davis, C.; Makov, T.; Hertwich, E. Interactive Visualization and Industrial Ecology: Applications, Challenges, and Opportunities. *Journal of Industrial Ecology* **2018**.
29. Krausmann, F.; Wiedenhofer, D.; Lauk, C.; Haas, W.; Tanikawa, H.; Fishman, T.; Miatto, A.; Schandl, H.; Haberl, H. Global Socioeconomic Material Stocks Rise 23-Fold over the 20th Century and Require Half of Annual Resource Use. *Proceedings of the National Academy of Sciences* **2017**, 114, 1880–1885.
30. Schandl, H.; Fischer-Kowalski, M.; West, J.; Giljum, S.; Dittrich, M.; Eisenmenger, N.; Geschke, A.; Lieber, M.; Wieland, H.; Schaffartzik, A.; Krausmann F.; Gierlinger S.; Hosking K.; Lenzen M.; Tanikawa H.; Miatto A.; and Fishman T. Global Material Flows and Resource Productivity: Forty Years of Evidence. *Journal of Industrial Ecology* **2017**.
31. Yoshida, K.; Fishman, T.; Okuoka, K.; Tanikawa, H. Material Stock's Overburden: Automatic Spatial Detection and Estimation of Domestic Extraction and Hidden Material Flows. *Resources, Conservation and Recycling* **2017**, 123, 165–175.
32. Miatto, A.; Schandl, H.; Fishman, T.; Tanikawa, H. Global Patterns and Trends for Non-Metallic Minerals Used for Construction. *Journal of Industrial Ecology* **2017**, 21 (4), 924–937.
33. Fishman, T.; Schandl, H.; Tanikawa, H. Stochastic Analysis and Forecasts of the Patterns of Speed, Acceleration, and Levels of Material Stock Accumulation in Society. *Environmental Science & Technology* **2016**, 50 (7), 3729–3737.
34. Martinico-Perez, M. F. G.; Fishman, T.; Okuoka, K.; Tanikawa, H. Material Flow Accounts and Driving Factors of Economic Growth in the Philippines. *Journal of Industrial Ecology* **2016**, 21 (5), 1226–1236.
35. Fishman, T.; Schandl, H.; Tanikawa, H. The Socio-Economic Drivers of Material Stock Accumulation in Japan's Prefectures. *Ecological Economics* **2015**, 113, 76–84.
36. Tanikawa, H.; Fishman, T.; Okuoka, K.; Sugimoto, K. The Weight of Society over Time and Space: A Comprehensive Account of the Construction Material Stock of Japan, 1945-2010. *Journal of Industrial Ecology* **2015**, 19 (5), 778–791.
37. Fishman, T.; Schandl, H.; Tanikawa, H.; Walker, P.; Krausmann, F. Accounting for the Material Stock of Nations. *Journal of Industrial Ecology* **2014**, 18 (3), 407–420.

Book chapters

1. Tanikawa, H.; Guo, J.; Fishman, T. Spatial-Temporal Views on Urban Construction Material Flow and Stock towards Sustainability. In *Routledge Handbook of the Extractive Industries and Sustainable Development*; Yakovleva, N., Nickless, E., Eds.; Routledge: London, 2022.
2. Chertow, M. R.; Kanaoka, K. S.; Miller, T. R.; Berrill, P.; Wolfram, P.; Heeren, N.; Fishman, T. The Systems Science of Industrial Ecology: Tools and Strategies Toward Meeting the Sustainable Development Goals. In *Science, Technology and Innovation for Sustainable Development Goals: Insights from Agriculture, Health, Environment, and Energy*; Adenle, A. A., Chertow, M. R., Moors, E. H. M., Pannell, D. J., Eds.; Oxford University Press: New York, NY, 2020.

Reports

1. International Resource Panel, 2020. *Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future: A report of the International Resource Panel*. United Nations Environment Programme, Nairobi, Kenya. Contributing author.
2. United Nations Environment Programme 2019. *Emissions Gap Report 2019*. United Nations Environment Programme, Nairobi, Kenya. Contributing author chapter 7.
3. United Nations Environment Programme 2016. *Global Material Flows and Resource Productivity. An Assessment Study of the UNEP International Resource Panel*. United Nations Environment Programme, Paris, France. Co-author.

Book reviews

1. Fishman, T. Book Review of Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers, 2nd Ed., by P. H. Brunner and H. Rechberger. *Journal of Industrial Ecology* **2017**.

Other publications

1. Fishman, T.; Sorek, M.; Mager, A. From waste to resource: the need for urban mining in Israel's built environment. *Ecology and Environment* **2020**, 11 (4), 49–51. *In Hebrew: פישמן, ת.; שורק, מ.; מגר, ע. מפסולת למשאב – הצורך בכרייה אורבנית בסביבה הבנויה בישראל. אקולוגיה וסביבה* **2020**, 11 (4), 49–51.

Languages

English, fluent, TOEIC score 990/990.

Hebrew, mother tongue.

Japanese, Japanese Language Proficiency Test (日本語能力試験) level N2.

Dutch, level A1.